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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : **H04B 7/26**	**A1**	**(11) International Publication Number:** **WO 93/22849** **(43) International Publication Date:** 11 November 1993 (11.11.93)

(21) International Application Number: PCT/FI93/00195

(22) International Filing Date: 6 May 1993 (06.05.93)

(30) Priority data:
922046 6 May 1992 (06.05.92) FI

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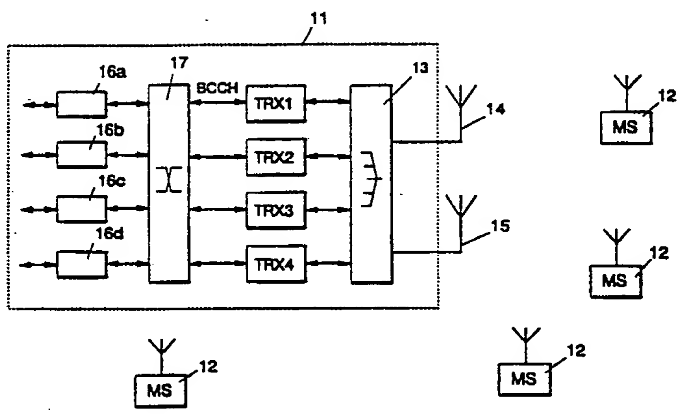
(81) Designated States: AU, GB, JP, NO, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
In English translation (filed in Finnish).

(54) Title: CELLULAR SYSTEM



(57) Abstract

The invention relates to a digital TDMA/FDMA (Time Division Multiple Access/Frequency Division Multiple Access) cellular network system, comprising (i) base stations (11) forming radio cells (C1 to C62), each of said base stations having a determined static frequency of a control channel of the cell and comprising a first transceiver (TRX1) transmitting continuously control data of the system concerning said cell at said control channel frequency at least in one predetermined time slot (TSO) of a TDMA frame (40), the TDMA frame of said first transceiver including traffic channels at least in a part of the other time slots, and at least one second transceiver (TRX2...TRX4) for the traffic channels, and (ii) mobile stations (12) connected to the base stations (11) via a radio path. To provide a system suitable for a microcellular network and to maximize the advantage to be gained from interference diversity, the traffic channels of said second transceiver units (TRX2...TRX4) use frequency hopping at least in a part of the radio cells in such a way that, on those traffic channels aligned with the predetermined time slots (TSO) of the control data of the cell in said first transceiver (TRX1), substantially all frequencies of the available frequency band, except said control data transmission frequency determined for the cell, belong to the hopping sequence, and on those traffic channels which are in the other time slots, (TSN, N$\neq$0), substantially all frequencies of the available frequency band belong to the hopping sequence.

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CELLULAR SYSTEM.

The invention relates to cellular network systems according to the preambles of the attached claims 1, 6 and 11. The cellular network systems according to the invention may conform to the GSM system known per se, for instance.

New requirements arise when mobile phone services are offered in urban population centres: the system is supposed to have a large capacity, base station equipment should be small-sized because of the very limited possibilities of providing equipment rooms in urban areas, and the system should operate on low radio power levels to make small-sized subscriber's units possible. Moreover, the system is expected to cover also the interior of buildings and to offer a good coverage in spite of the fact that it is difficult to predict the radio coverage of antennas to be positioned at low elevations. In addition to the above, the system is supposed to offer an easier frequency planning of a radio network than before. Such cellular networks are built of so-called short-range microcells.

To build a mobile phone network in an environment as described above is a task very different from realizing a classic cellular network. While the primary object of a cellular network is to minimize the number of base station sites by increasing the range of the cells to the technical maximum and by installing the maximum number of transceiver units permitted by the frequency band of the network on each base station site, the primary object of microcellular networks is to achieve low radio powers and small installation units suitable for outdoor deployment.

However, conventional cellular technique (cell

splitting) does not meet the requirements of a microcellular network. This is due to the fact that with the cell radius decreasing and the radio coverage at the same time becoming more difficult to predict than before (because antennas are positioned below rooftops to restrict the cell size) either the overlapping of the cells increases or the coverage of the system is compromised (depending on a shadowing caused by buildings or natural obstacles in each direction). An increasing degree of overlapping of the cells makes it necessary to widen the reuse pattern, which eliminates at least part of the additional capacity supposed to be obtained by means of cell splitting.

The object of the present invention is thus to provide a digital TDMA/FDMA (Time Division Multiple Access/Frequency Division Multiple Access) cellular network system, e.g. a TDMA/FDMA cellular system according to the GSM system, in order to comply with the above requirements for a microcellular network. This is achieved by means of a cellular network system according to the present invention, the first embodiment of which is characterized in what is set forth in the characterizing portion of the attached claim 1, the second embodiment of which is characterized in what is set forth in the characterizing portion of the attached claim 6 and the third embodiment of which is characterized in what is set forth in the characterizing portion of claim 11.

The basic idea of the invention is to give up the classic cell planning, according to which a part (particular frequencies) of a frequency band available is allocated to each cell, and to utilize instead (within the scope of the restrictions placed by the other properties of the system) substantially the

full available frequency band in as many cells as possible, preferably in all cells of the system.

The difference between the idea of the invention and that of the prior art may be described more accurately as follows. Conventional cell planning tries to find the densest reuse pattern, by means of which a limited available frequency band can be effectively utilized (the denser the reuse pattern, the greater the capacity). This takes place in such a way that the number (K) of the coverage areas (cells or sectors) of a reuse pattern is first derived from the minimum required for C/I (carrier-to-interference ratio) of the system (GSM system requires 9 dB, for instance). The available frequency band is then divided evenly among the coverage areas. The basis for the present invention is a very different idea: cell planning is simplified by choosing the number (K) of the coverage areas of the reuse pattern to equal with the number of available carriers on the frequency band. The capacity of the system is then increased by adding frequency hopping transceivers, each of which is hopping across the whole width of the frequency band. The collision probability can thus be spread over the whole area of the reuse pattern.

The solution of the invention also enables the considerable advantage that the frequency hopping sequences to be used in different cells need not be mutually synchronized, which means that there is no need to time synchronize the cells, i.e. TDMA frames need not be transmitted synchronously and at the same mutual timing. On the other hand, the invention makes it possible to utilize also the time synchronization between cells for a selective reduction of collision load on control channels, as is described in greater detail later.

In the present invention, the known frequency-hopping property of the known GSM system is thus utilized in a novel way, in other words in such a way that substantially the whole frequency band of the system is included in the hopping sequences of the cells. A frequency-hopping chain of all cells then includes the same frequencies, i.e. all frequencies of the system (with certain exceptions due to the other properties of the system).

According to the frequency-hopping principle, the transmission frequency is changed throughout the transmission of a signal and the receiving frequency during reception, respectively, by using a suitable number of frequencies, e.g. four predetermined frequencies. These frequencies form a so-called hopping sequence. Within one cell, the hopping sequences are mutually synchronized (collisions do not occur between the channels of any one single cell) and non-correlated among cells sharing the same allocated frequencies. In the GSM system, frequency hopping is an optional feature for a base station and an obligatory one for a mobile station.

Two kinds of advantages are gained from the use of frequency-hopping, namely so-called frequency and interference diversity effects. The desirable effect of frequency diversity is based on the fact that fading conditions are mutually uncorrelated across consequent time slot occurencies, when the frequency of a radio connection is changed sufficiently from one time slot to another. Even stationary (or slowly moving) users, which for a certain frequency are in a fading notch, are then regularly also in a strong field on some other carriers belonging to the hopping sequence. On the other hand, the useful effect of interference diversity is caused by the mutual uncor-

relatedness of the hopping sequences, i.e. by the fact that the frequency-hopping sequences of the base stations using the same or nearby frequencies are mutually different, whereby connections interfering each other change when moving from one time slot to another. In this way, the influence of strong interference sources is averaged over several channels. The radio system and frequency-hopping of the GSM system are described in greater detail in the reference [1] cited (the list of references cited is at the end of the specification).

Thanks to the solution of the present invention, the benefit from interference diversity can be exploited to its full potential. Because the system of the invention reuses substantially all frequencies preferably in all cells, an increasing degree of overlapping of the cells in a denser becoming cellular network does not make it necessary to relax the reuse pattern (because the interference is only momentary), which brings a distinct advantage of capacity compared to conventional solutions.

In the following, the invention and its preferred embodiments will be described in greater detail referring to the examples according to the attached drawings illustrating a GSM network, in which

Figure 1 shows schematically one cell of a cellular network system,

Figure 2 shows schematically a reuse of frequencies in a case known per se, in which a cellular structure consists of a reuse pattern of 9 cells,

Figure 3 shows schematically an allocation of BCCH/CCCH frequencies in the cellular network system according to the invention,

Figure 4 shows schematically frequencies used in one cell of the cellular network system according

to a first embodiment of the invention in a time slot corresponding to a BCCH/CCCH time slot,

Figure 5 shows schematically frequencies used in one cell of the cellular network system according to the first embodiment of the invention in the other time slots of a TDMA frame and

Figure 6 shows schematically frequencies used in one cell of the cellular network system according to a second embodiment of the invention.

Figure 1 illustrates a cellular network system within the area of one radio cell. A base station 11 forms a radio cell of its own and serves subscribers 12 moving in the area of this cell and being in connection with their base station via a radio path. The base station comprises at least two, in this case four transceiver units, which are indicated by reference marks TRX1...TRX4. The outputs of the transmitters are connected to a combining element 13 at radio frequency, which element connects the transmitters of the transceivers to a common transmitting antenna 14 and the receivers of the transceivers to a common receiving antenna 15. The combining element 13 is a wideband combiner suitable for being used in association with frequency-hopping transceivers. Because of the losses of a wideband combiner, the number of transceivers to be connected to the same antenna is limited.

The base station further comprises several baseband signal processing units 16a to 16d, which produce baseband modulating signals for the transceiver units TRX1...TRX4. In the signal processing units, the data to be transmitted is coded and positioned into a frame structure. Between the signal processing units and the transmitters, there is a switching field 17 connecting the baseband signals to

be transmitted to the transmitters and the signals to be received to the signal processing units, respectively.

One of the transceiver units of the base station (in this case the transceiver unit TRX1) transmits on a BCCH/CCCH channel. The transmission frequency (BCCH/CCCH frequency) of this transceiver unit is fixed in each cell. The BCCH/CCCH channel will be described more closely below.

Because the number of transceivers to be equipped for the cells of the system is smaller than the number of the channels of the system, hopping synthetizers shall be used in the transceivers of the cellular network system according to the invention.

The cellular network naturally comprises also other components, but because the basic structure of the network is known per se, it will not be described more closely in this connection. As to the basic structure of a GSM network, reference is made e.g. to the reference [2] cited.

In Figure 2, the cellular network system is shown as a combination of ideal hexagons, each of which represents one cell 10. According to conventional frequency planning, hexagons are formed in a known manner to reuse patterns, to so-called clusters, which clusters 20 typically comprise e.g. 9 cells, as shown in Figure 2. Frequencies available are divided among the cells of a cluster and respective frequencies are reused again in the respective cells of the next cluster. In Figure 2, the frequency combination of each cell is indicated by reference marks A to I. For instance, on a 12,5 MHz band with 62 available carrier frequencies, the difference between the carriers being 200 kHz, six or seven frequencies are allocated to each cell from said fre-

quency band.

One of the control channels of the GSM system is a Broadcast Control CHannel BCCH, which is a uni-directional channel from the base station to the mobile stations. Another control channel of the GSM system is a Common Control CHannel CCCH, which is used for establishing a signalling connection only. The BCCH and CCCH channels occurring at the same carrier frequency share one time slot in a multiframe structure of 51 frames. A BCCH/CCCH carrier consists of a TDMA frame of 8 time slots. One of the time slots is used commonly by the BCCH and CCCH channels (as well as by a frequency correction channel FCH and a synchronizing channel SCH) (51 multiframe). The other time slots of the BCCH/CCCH carrier may be traffic channels.

Even though a power control as per channel (as per time slot) is known in the GSM system, the BCCH/CCCH carrier must transmit at maximum power in all time slots, because the mobile stations monitor the surrounding cells after having read the frequencies of the neighbouring cells from their active cell. A mobile station can measure the level of the neighbouring cells only momentarily, due to which there is no guarantee that the measurement occurs exactly in the time slot comprising the BCCH/CCCH channel. For this reason, the cell must transmit this frequency in all time slots at fixed (maximum) power. The mobile station utilizes these measuring data in order to conclude, whether the field strength of some other cell is so much stronger that it is worth while abandoning the present cell and beginning to listen to the call channel of a new cell. A similar monitoring controls a handover process, when the mobile station is in an active state, in other words, in the case of

a call.

Because one time slot (BCCH/CCCH time slot) of the BCCH/CCCH carrier is shared (within the scope of the multiframe structure) also by other control channels (frequency correction channel FCH and synchronizing channel SCH), the references to the BCCH or CCCH channels shall be understood to concern generally also other control channels of a similar type (common in a cell). (These control channels are described in greater detail e.g. in the above-mentioned reference [1] cited.)

Consequently, each cell 10 of the GSM system comprises a transmitter (such as a beacon) at a fixed frequency and with a permanently constant power, on the basis of which the mobile stations can, for instance, decide to which of the available cells they stick in an idle state. On grounds of the measurements of the neighbouring cells, the system makes a decision on a handover of a mobile station in a call state. Consequently, no hopping synthetizer can be used at the BCCH/CCCH frequency of a cell (whereby the BCCH/CCCH channel could be seen only at intervals at the frequency allocated to said cell).

On account of the described properties of the GSM system, the main principle of the present invention (the transceivers use frequency hopping in such a way that substantially all frequencies of an available frequency band belong to the hopping sequences) has been varied in such a manner that conventional frequency planning is applied to the BCCH/CCCH frequencies of the cells, which means that the control carrier has a predetermined fixed frequency in each cell. Differing from the conventional frequency planning, the system according to the invention does not, however, require the maximum capacity of the cluster

to be reused (because only one BCCH/CCCH frequency is allocated to each cell), and therefore, the cluster size can be preferably the same as the number of radio frequencies available in the system. Consequently, on a 12,5 MHz band, for instance, the size of the cluster can be 62 cells, if the difference between the carriers is 200 kHz. Frequency planning can be very much simplified by such a large cluster size, in spite of the irregular radio coverage of the cells.

Figure 3 shows schematically the allocation of the BCCH/CCCH frequencies in a case similar to that described above, in which the cluster size is 62 cells. The cells of the cluster are indicated by reference marks C1 to C62. The BCCH/CCCH frequency of the cell C1 is f1, the BCCH/CCCH frequency of the cell C2 is f2, etc., and the BCCH/CCCH frequency of the last cell C62 is f62.

As mentioned above, the frequency of the BCCH/CCCH channel cannot hop, but the transmitter in question transmits at a fixed frequency and at constant power in all time slots of a TDMA frame. Respectively, in order to protect the BCCH/CCCH channel from other frequencies hopping according to the invention, the BCCH/CCCH frequency cannot be present on the frequency hopping sequences of the other radio channels of the same cell in the time slot corresponding to the BCCH/CCCH time slot of said other radio channels.

Figures 4 and 5 show this principle schematically.

Figure 4 shows frequencies used by all other transmitters of one cell, in this example case C46, except by the BCCH/CCCH transmitter (transceiver units TRX2 to TRX4 in Figure 1), in a time slot TS0 corresponding to the BCCH/CCCH time slot and being the first time slot of a TDMA frame 40. As presented

above, the BCCH/CCCH frequency of the cell C46 is f46, and each other transceiver unit has the frequencies f1 to f45 and f47 to f62 at its disposal in the time slot TS0 corresponding to the BCCH/CCCH time slot. Consequently, generalized for all cells, this means that the transceivers, except the transmitter operating on the control carrier (BCCH/CCCH), use frequency hopping in the cells of the network in such a way that substantially all frequencies of the available frequency band belong to the hopping sequences, except the frequency of the control carrier of the own cell in the time slot corresponding to the control channel.

According to Figure 5, respectively, each transmitter of the cell C46, except the BCCH/CCCH transmitter, has all the frequencies f1 to f62 at its disposal in all those time slots of the TDMA frame 40 which do not correspond to the BCCH/CCCH time slot (TSN, N≠0). Generalized for all cells, each transceiver unit of each cell, except the BCCH/CCCH transmitter, has all the frequencies at its disposal in these time slots. Consequently, each one of these transmitter units transmits 1/62 of the transmission time of each channel at a certain individual transmission frequency.

In one embodiment of the invention, the other time slots (7 in number) of the BCCH/CCCH carrier, which time slots may be traffic channels, remain at the same fixed frequency and only channels at other frequencies hop as described above. In a second embodiment, said traffic channel time slots of the BCCH/CCCH carrier hop between the BCCH/CCCH transmitter operating at a fixed frequency and the other (hopping) transmitters of the cell in accordance with a local hopping sequence of the cell to be realized

in a baseband switching field 17 (Figure 1), for instance. The switching field 17 connects said channels frame by frame to different transceiver units. In this last-mentioned embodiment, in which all channels are treated equally, irrespective of whether they belong to a fixed frequency BCCH/CCCH transceiver unit or to other transceiver units, the interference diversity to be obtained from frequency hopping can be preferably maximized.

In case if the other time slots (7 in number) on the BCCH/CCCH carrier remain at the same fixed frequency, they are exposed to interference from (hopping) frequencies of the other transceiver units. In the above embodiment, the BCCH/CCCH frequency of the own cell has been eliminated from the frequency hopping sequences only in the time slot corresponding to the BCCH/CCCH time slot. This is caused, on the one hand, by the fact that the control channel (BCCH/ CCCH channel) is considered to be more critical as far interference is concerned than an ordinary traffic channel and, on the other hand, by the fact that said interference is only momentary. However, the momentary interference caused by the (hopping) frequencies of the other transceivers to the other channels on the BCCH/CCCH carrier can be entirely eliminated by excluding the BCCH/CCCH frequency of the own cell from the frequency hopping sequences in all time slots (TS0...TS7). This causes, however, a slightly greater loss of capacity, respectively. The last-mentioned alternative is shown in Figure 6, as far as the cell C46 is concerned.

Moreover, it shall be noted that the above embodiments are such that there is no need to time synchronize the cells with each other.

Moreover, the principle of the invention leads

to the fact that the other cells of the system use the BCCH/CCCH frequency of the interfered cell also in the BCCH/CCCH time slot and thus interfere the BCCH/CCCH channel of this cell. However, a consequence of the natural topology of the network is that the most cells are too far away in order to cause any significant interference. Transmitters of each cell spend 1/62 of the transmission time at the BCCH/CCCH frequency of said interfered cell. It depends on the equipped capacity of the cells and on the prevailing traffic situation, whether the interference level of the BCCH/CCCH channel rises too high.

However, interference tolerance of the BCCH/CCCH channel is improved by the fact that the maximum power of the cell is used on the BCCH/CCCH channel under all circumstances. The other users hopping at the same frequency operate in most cases on a lower power level controlled by power control. Due to this, it is highly probable that the BCCH/CCCH channel copes with collisions without an unreasonable increase of the error ratio. On the other hand, a sufficient amount of frequency resources are placed at the other users' disposal from other frequencies (at which the peak power BCCH/CCCH carrier is topologically farther away), from a more equal situation of competition, so that these users will be able to maintain a sufficient quality of a radio connection.

However, if the interference level of the BCCH/CCCH channel rises too high, in spite of the topological distance mentioned above and differences in the power level, the principle of the invention can be applied in such a way that traffic channels corresponding to the BCCH/CCCH time slot are blocked from being used by the other (hopping) radio channels of the network. In other words, the system does not con-

nect a call to a time slot corresponding to the BCCH/CCCH time slot in cells surrounding the cell which suffers from excessive interference on the BCCH/CCCH channel. In this way, it is possible to reduce selectively the intensity of collisions occurring on the BCCH/CCCH channels so that channel coding and interleaving of the system yield a sufficiently low error ratio. This procedure naturally reduces the capacity of the system of the invention, but the reduction is restricted to concern only certain cells and exclusively the BCCH/CCCH time slot (TS0). The last-mentioned embodiment can be varied in principle also in such a manner that only the BCCH/CCCH frequency of the own cell and the frequency or frequencies corresponding to the BCCH/CCCH frequency of one or several other (interfered) cells are eliminated from the frequency hopping sequences in a time slot corresponding to the BCCH/CCCH time slot. In the two last-mentioned embodiments, the cells shall be mutually time synchronized in such a way that the TDMA frames are transmitted synchronously and at the same mutual timing.

Though the invention has been described above referring to the example of the attached drawing, it is obvious that the invention is not restricted to that, but it can be modified in many ways within the scope of the inventive idea presented above and in the attached claims.

List of References cited:

[1] Recommendation GSM 05.01 "Physical Layer on the radio path: General description."

[2] Recommendation GSM 01.02 "General Description of a GSM PLMN".

Claims:

1. A digital TDMA/FDMA (Time Division Multiple Access/Frequency Division Multiple Access) cellular network system, comprising

- base stations (11) forming radio cells (C1 to C62), each of said base stations having a determined static frequency of a control channel of the cell and comprising a first transceiver (TRX1) transmitting continuously control data of the system concerning said cell at said control channel frequency at least in one predetermined time slot (TS0) of a TDMA frame (40), the TDMA frame of said first transceiver including traffic channels at least in a part of the other time slots, and at least one second transceiver (TRX2...TRX4) for the traffic channels, and

- mobile stations (12) connected to the base stations (11) via a radio path, characterized in that the traffic channels of said second transceiver units (TRX2...TRX4) use frequency hopping at least in a part of the radio cells in such a way that, on those traffic channels aligned with the predetermined time slots (TS0) of the control data of the cell in said first transceiver (TRX1), substantially all frequencies of the available frequency band, except said control data transmission frequency determined for the cell, belong to the hopping sequence, and on those traffic channels which are in the other time slots (TSN, N≠0), substantially all frequencies of the available frequency band belong to the hopping sequence.

2. A cellular network system according to claim 1, characterized in that said frequency hopping is used in each cell thereof.

3. A cellular network system according to claim

1 or 2, c h a r a c t e r i z e d in that the frequency hopping sequences to be used in different cells are mutually non-synchronous.

4. A cellular network system according to claim 1, c h a r a c t e r i z e d in that all channels of a carrier of said first transceiver unit (TRX1) remain at the same fixed frequency.

5. A cellular network system according to claim 1, c h a r a c t e r i z e d in that frequency hopping is carried out on the traffic channels of the carrier of said first transceiver unit (TRX1) by connecting said channels according to a predetermined sequence to the second transceiver units (TRX2... TRX4).

6. A digital TDMA/FDMA (Time Division Multiple Access/Frequency Division Multiple Access) cellular network system, comprising

- base stations (11) forming radio cells (C1 to C62), each of said base stations having a determined static frequency of a control channel of the cell and comprising a first transceiver (TRX1) transmitting continuously control data of the system concerning said cell at said control channel frequency at least in one predetermined time slot (TS0) of a TDMA frame (40), the TDMA frame of said first transceiver including traffic channels at least in a part of the other time slots, and at least one second transceiver (TRX2 ...TRX4) for the traffic channels, and

- mobile stations (12) connected to the base stations (11) via a radio path, c h a r a c t e r i z e d in that the traffic channels of said second transceiver units (TRX2...TRX4) use frequency hopping at least in a part of the cells in such a way that substantially all frequencies of the available frequency band, except said control data transmission

frequency determined for the cell, belong to the hopping sequence on all traffic channels.

7. A cellular network system according to claim 6, characterized in that said frequency hopping is used in each cell.

8. A cellular network system according to claim 6 or 7, characterized in that the frequency hopping sequences to be used in different cells are mutually non-synchronous.

9. A cellular network system according to claim 6, characterized in that all channels of a carrier of said first transceiver unit (TRX1) remain at the same fixed frequency.

10. A cellular network system according to claim 6, characterized in that frequency hopping is carried out on the traffic channels of the carrier of said first transceiver unit (TRX1) by connecting said channels according to a predetermined sequence to the second transceiver units (TRX2... TRX4).

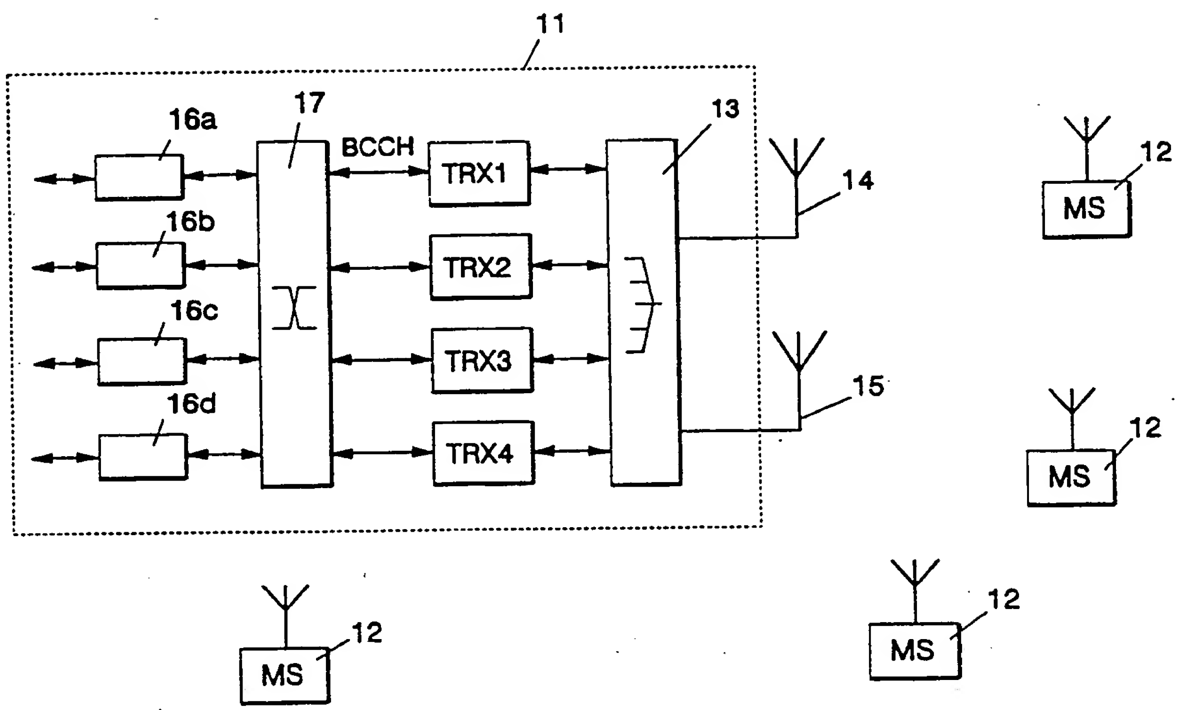
11. A digital TDMA/FDMA (Time Division Multiple Access/Frequency Division Multiple Access) cellular network system, comprising

- base stations (11) forming radio cells (C1 to C62), each of said base stations having a determined static frequency of a control channel of the cell and comprising a first transceiver (TRX1) transmitting continuously control data of the system concerning said cell at said control channel frequency at least in one predetermined time slot (TS0) of a TDMA frame (40), common to all radio cells of the system, the TDMA frame of said first transceiver including traffic channels at least in a part of the other time slots, and at least one second transceiver (TRX2... TRX4) for the traffic channels, whereby the radio

cells are mutually synchronized in such a way that the TDMA frames are transmitted synchronously and at the same mutual timing, and

- mobile stations (12) connected to the base stations (11) via a radio path, characterized in that the traffic channels of said second transceiver units (TRX2...TRX4) use frequency hopping at least in a part of the radio cells in such a way that, on those traffic channels aligned with the predetermined time slots (TS0) of the control data of the cell in said first transceiver (TRX1), substantially all frequencies of an available frequency band, except said control data transmission frequency determined for the cell, belong to the hopping sequence, and on those traffic channels which are in the other time slots (TSN, N≠0), substantially all frequencies of the available frequency band belong to the hopping sequence, and that for reducing the interference exposure of the control channels of the other radio cells of the system, a time slot aligned with the time slot determined in the system for transmitting control data of the cell is blocked from being used at least by one of said second transceivers (TRX2...TRX4), at least at one of the base stations (11) of the system.

12. A cellular network system according to claim 11, characterized in that said frequency hopping is used in each radio cell thereof.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16a
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16d
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BCCH
TRX1
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FIG. 1

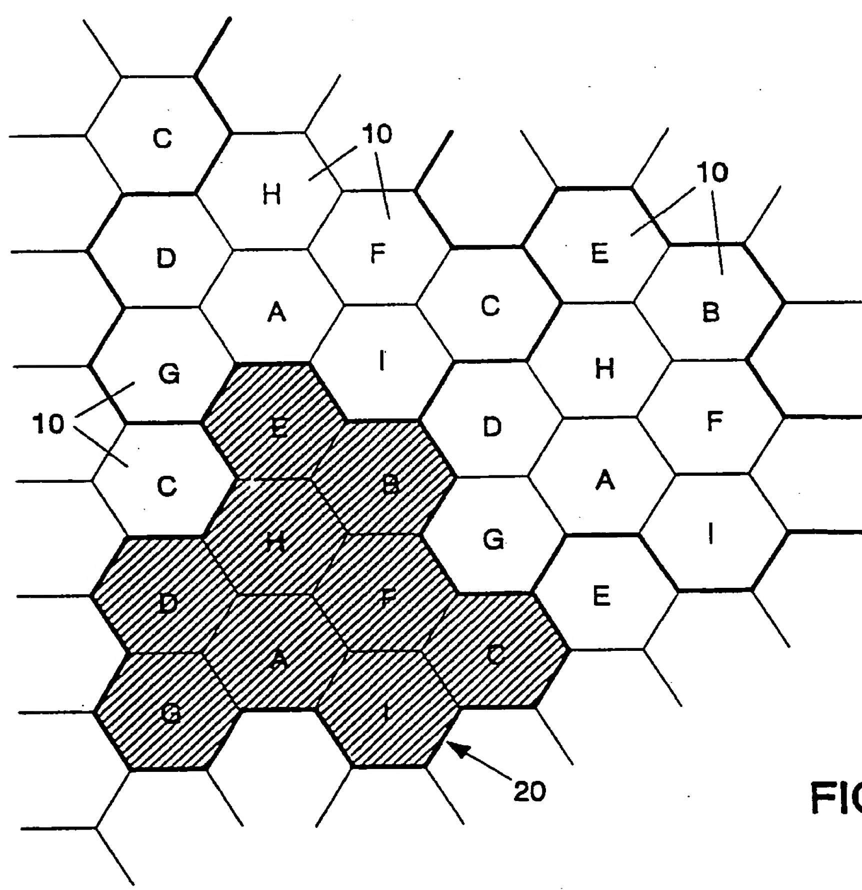
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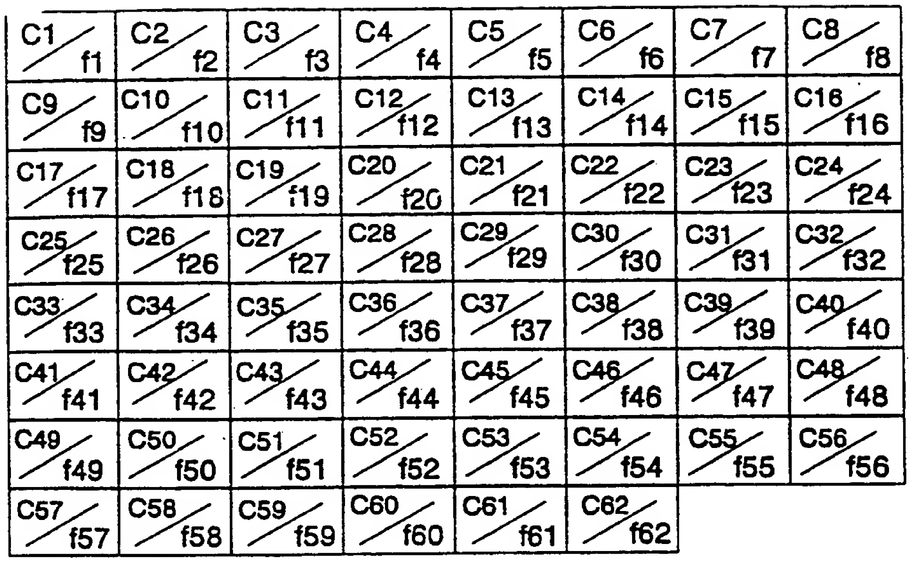
FIG. 2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C9 f9 C10 f10 C11 f11 C12 f12 C13 f13 C14 f14 C15 f15 C16 f16
C17 f17 C18 f18 C19 f19 C20 f20 C21 f21 C22 f22 C23 f23 C24 f24
C25 f25 C26 f26 C27 f27 C28 f28 C29 f29 C30 f30 C31 f31 C32 f32
C33 f33 C34 f34 C35 f35 C36 f36 C37 f37 C38 f38 C39 f39 C40 f40
C41 f41 C42 f42 C43 f43 C44 f44 C45 f45 C46 f46 C47 f47 C48 f48
C49 f49 C50 f50 C51 f51 C52 f52 C53 f53 C54 f54 C55 f55 C56 f56
C57 f57 C58 f58 C59 f59 C60 f60 C61 f61 C62 f62

FIG. 3

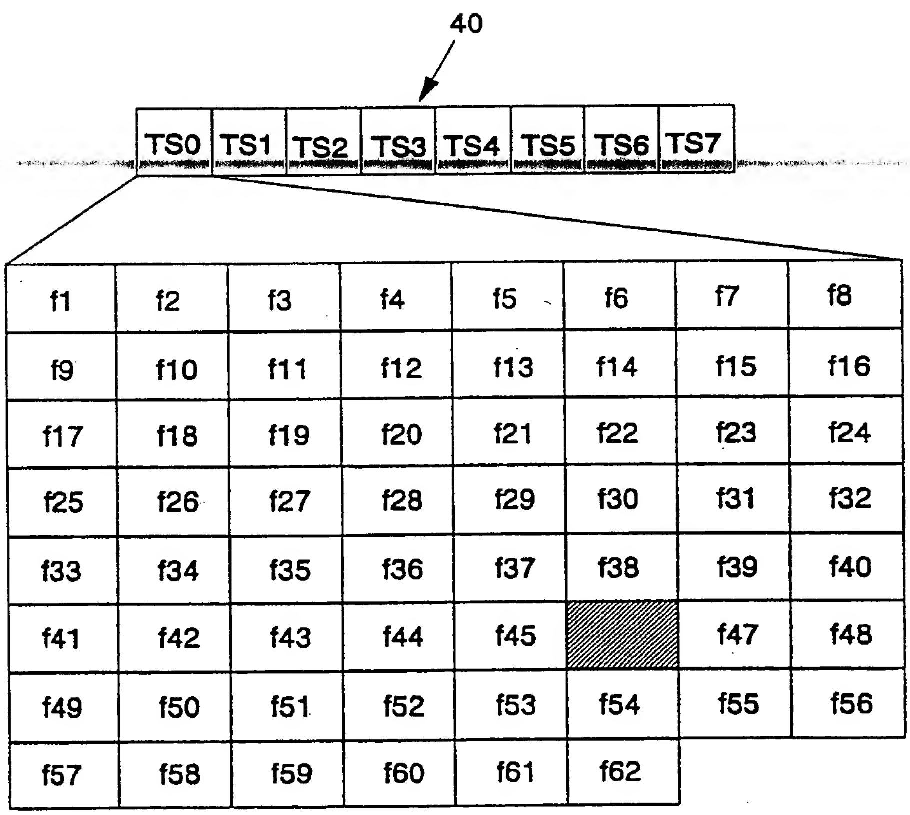
40
TS0 TS1 TS2 TS3 TS4 TS5 TS6 TS7
f1 f2 f3 f4 f5 f6 f7 f8
f9 f10 f11 f12 f13 f14 f15 f16
f17 f18 f19 f20 f21 f22 f23 f24
f25 f26 f27 f28 f29 f30 f31 f32
f33 f34 f35 f36 f37 f38 f39 f40
f41 f42 f43 f44 f45 f47 f48
f49 f50 f51 f52 f53 f54 f55 f56
f57 f58 f59 f60 f61 f62

FIG. 4

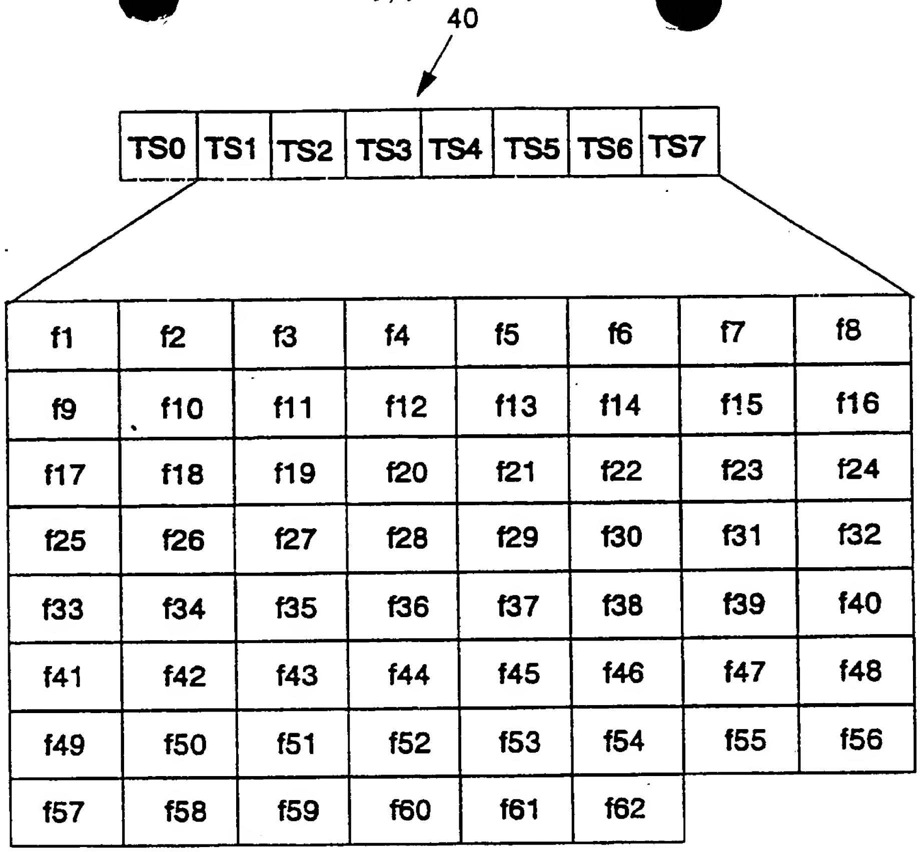
40
TS0 TS1 TS2 TS3 TS4 TS5 TS6 TS7
f1 f2 f3 f4 f5 f6 f7 f8
f9 f10 f11 f12 f13 f14 f15 f16
f17 f18 f19 f20 f21 f22 f23 f24
f25 f26 f27 f28 f29 f30 f31 f32
f33 f34 f35 f36 f37 f38 f39 f40
f41 f42 f43 f44 f45 f46 f47 f48
f49 f50 f51 f52 f53 f54 f55 f56
f57 f58 f59 f60 f61 f62

FIG. 5

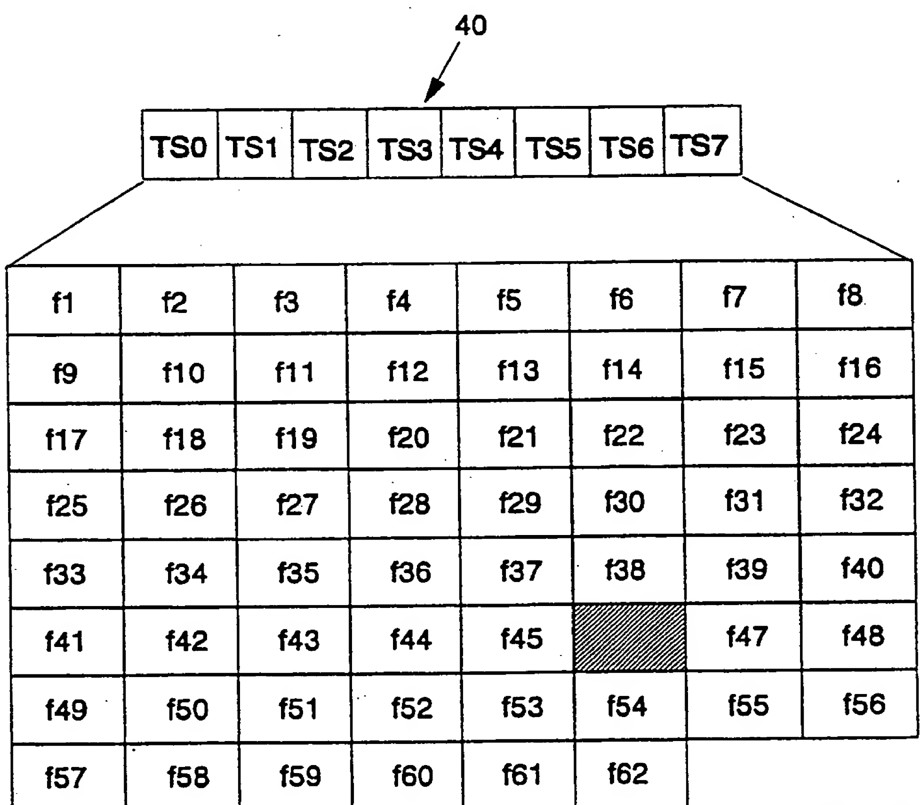
40
TS0 TS1 TS2 TS3 TS4 TS5 TS6 TS7
f1 f2 f3 f4 f5 f6 f7 f8
f9 f10 f11 f12 f13 f14 f15 f16
f17 f18 f19 f20 f21 f22 f23 f24
f25 f26 f27 f28 f29 f30 f31 f32
f33 f34 f35 f36 f37 f38 f39 f40
f41 f42 f43 f44 f45 f47 f48
f49 f50 f51 f52 f53 f54 f55 f56
f57 f58 f59 f60 f61 f62

FIG. 6

INTERNATIC[illegible]. SEARCH REPORT

[illegible]rnational application No.
PCT/FI 93/00195

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: H04B 7/26
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: H04B, H04Q, H04J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DIALOG: WPI, CLAIMS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO, A1, 9016122 (ITALTELSOCIETA ITALIANA TELECOMMUNICAZIONI S.P.A.), 27 December 1990 (27.12.90), page 1, line 11 - page 2, line 6; page 7, line 12 - line 14, figures 1-2 --	1-10
X	WO, A1, 9113502 (MOTOROLA INC.), 5 Sept 1991 (05.09.91), page 3, line 13 - page 6, line 19, abstract --	1-10
A	US, A, 4799252 (EIZENHÖFFER ET AL), 17 January 1989 (17.01.89), column 3, line 4 - line 65 --	1-12

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 July 1993	27 -07- 1993
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Michael Felhendler Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 4554668 (DEMAN ET AL), 19 November 1985 (19.11.85), figure 1, abstract --	1-12
A	US, A, 4479226 (V.K. PRABHU ET AL), 23 October 1984 (23.10.84), figures 1-5, abstract -- --------	1-12

INTERNATIONAL SEARCH REPORT
Information on patent family members

02/07/93

International application No.
PCT/FI 93/00195

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
WO-A1-	9016122	27/12/90	EP-A-	0392987	17/10/90
WO-A1-	9113502	05/09/91	NONE		
US-A-	4799252	17/01/89	AU-B-	591691	14/12/89
			AU-A-	6059886	05/02/87
			CA-A-	1280228	12/02/91
			DE-A-	3527331	05/02/87
			DE-A-	3685618	16/07/92
			EP-A,B-	0211460	25/02/87
US-A-	4554668	19/11/85	CA-A-	1214215	18/11/86
			EP-A,B-	0095959	07/12/83
US-A-	4479226	23/10/84	CA-A-	1199682	21/01/86
			EP-A,B-	0104206	04/04/84
			SE-T3-	0104206	